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**PATENT SPECIFICATION**  
NO DRAWINGS



**832,175**

Date of Application and filing Complete Specification Nov. 4, 1958.

No. 35359/59.

Application made in Germany on Nov. 30, 1957.

Complete Specification Published April 6, 1960.

Index at acceptance:—Class 96, A7B(9:14).

International Classification:—D21f.

**COMPLETE SPECIFICATION**

**Improvements in or relating to methods for use in the  
Manufacture of Fibrous Webs**

I, PAUL LIPKE, of 17, Augustastrasse,  
Neuwied, Germany, a Citizen of the Federal  
Republic of Germany, do hereby declare the  
following:

tric current operates unfavourably with a heat utilization of 3000—4500 kilowatt-hours, and when it is also taken into account that a steam power generator installation makes high de- 45

**ERRATUM**

**SPECIFICATION No. 832,175**

Page 1, line 1, for "Lipke" read "Lippke"  
THE PATENT OFFICE  
24th May, 1960

30 must more power than was needed in the past, when the steam used in a dryer for a fibrous web was sufficient for generating in an intermediate pressure stage, the entire or almost the entire power required in the manufacture of the web; at the present day, however, it is normally necessary to provide additional sources of energy for driving the plant. These 35 additional energy sources are formed by local electric generating equipment driven by condensation turbines, or by outside electrical supplies.

40 When it is taken into account that the intermediate pressure stage of the steam required for drying is favourable if the amount of heat used is only 1200 to 1500 heat units per kilowatt-hour, but the condensation stage of the steam power installation for generating elec-

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manner of water removal and drying of fibrous webs it was necessary to have large amounts of steam available. The efficiency of the dryers for such webs is unfavourable so that, depending on the quality of the fibrous material and its degree of water removal, the thermal efficiency of the drier lies below 60%. 75

Attempts have also been made for the drying of fibrous webs to utilize waste heat contained in cooling water or exhaust gases of a diesel engine. However, these attempts have not been successful because the small amount of high level heat contained in exhaust gases having a temperature beyond 400° C. is not sufficient to generate sufficient steam for the drying of the web, and up to now it appeared not to be feasible in the manufacture of fibrous 80 85

*F. J. O.*

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## COMPLETE SPECIFICATION

### Improvements in or relating to methods for use in the Manufacture of Fibrous Webs

I, PAUL LIPKE, of 17, Augustastrasse, Neuwest, Germany, a Citizen of the Federal Republic of Germany, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:

The invention relates to methods for use in the manufacture of fibrous webs, for example paper webs.

The manufacture of webs of indefinite length of fibrous material such as paper or cardboard is at present dependent on the availability of great amounts of heat derived from steam. The supply of power and heat in connection with paper and cardboard making plant has previously been most favourably effected by a steam power installation which generates electric current required for the plant solely from the pressure and temperature gradient of high pressure superheated steam used for heating driers of the plant.

The present day high standards of quality required in connection with the disintegration and sorting of fibres and in connection with the separation of water from the fibres, need much more power than was needed in the past, when the steam used in a drier for a fibrous web was sufficient for generating in an intermediate pressure stage, the entire or almost the entire power required in the manufacture of the web; at the present day, however, it is normally necessary to provide additional sources of energy for driving the plant. These additional energy sources are formed by local electric generating equipment driven by condensation turbines, or by outside electrical supplies.

When it is taken into account that the intermediate pressure stage of the steam required for drying is favourable if the amount of heat used is only 1200 to 1500 heat units per kilowatt-hour, but the condensation stage of the steam power installation for generating elec-

tric current operates unfavourably with a heat utilization of 3000—4500 kilowatt-hours, and when it is also taken into account that a steam power generator installation makes high demands from the operating personnel and needs a high financial outlay for the erection of the entire installation then it becomes understandable that a more favourable source of heat and energy is desirable for plants for the manufacture of fibrous webs.

To meet this desire it has been proposed to use diesel engines having an essentially higher calorific efficiency for providing the required heat and electrical energy. The favourable feature lies in the fact that with present day working methods in a plant for the manufacture of fibrous webs only about 15% of the totally required electrical energy can be gained from the steam required for drying in the intermediate pressure stage, so that under favourable conditions 3000—3200 heat units have to be used per average kilowatt-hour required, while by means of a diesel engine a kilowatt-hour can be generated by only 2200 heat units.

Such previous proposals have however been unsuccessful, since for the hitherto usual manner of water removal and drying of fibrous webs it was necessary to have large amounts of steam available. The efficiency of the dryers for such webs is unfavourable so that, depending on the quality of the fibrous material and its degree of water removal, the thermal efficiency of the drier lies below 60%.

Attempts have also been made for the drying of fibrous webs to utilize waste heat contained in cooling water or exhaust gases of a diesel engine. However, these attempts have not been successful because the small amount of high level heat contained in exhaust gases having a temperature beyond 400° C. is not sufficient to generate sufficient steam for the drying of the web, and up to now it appeared not to be feasible in the manufacture of fibrous

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webs to utilize the greater part (21%) of heat primarily expended in a diesel engine.

The provision of a diesel engine thus required the additional generation of steam for drying, by means of a separate boiler, so that thereby the favourable thermal efficiency of the diesel engine and the advantage of the small amount of attention required were lost.

Other attempts which aimed at utilizing heat contained in cooling water at a temperature of 70° C. to 80° C. likewise remained unsuccessful owing to the expensive and complicated nature of the equipment required.

In the meantime, however, changes have taken place in the technique of manufacturing fibrous webs so that by the present invention it has become possible completely or at least almost completely to supply a plant for the manufacture of fibrous webs of indefinite length from fibrous material with energy by means of a diesel engine and an electric generator. The invention pre-supposes that the drying machines required for manufacturing such webs are constructed in accordance with the most modern principles for removing water from the web and for drying the web.

The present invention consists in a method for the manufacture of fibrous webs, for example paper webs, wherein heat for drying a web and electric energy are derived from a diesel engine plant, the web being treated in apparatus comprising a wet part having a sieve portion, and a dry part having a press portion, a subsequent air drier and a cylinder drier, comprising the steps of directly or indirectly utilizing heat from cooling water of the diesel engine plant in the sieve portion and press portion to heat the fibrous web, and to heat felts of the press portion for obtaining an improved water removal, and utilizing electric resistance heating or electric radiant heating of the web and of the felt of the last press of the press portion using electricity generated by the diesel engine plant whereby further to improve the water removal and increasing the temperature of the web, air for the subsequent air drier being heated by otherwise not utilizable waste heat of the exhaust gases and by heat remaining in the cooling water and not utilized in the sieve portion and the press portion, the web being preheated by electric radiators in a pre-drying zone preceding the cylinder drying part so that at the beginning of the cylinder drying part only such an amount of water remains in the web as can be dried out therefrom by heat derived from steam produced in an exhaust gas heated boiler.

Preferably, the air required for drying the web is first passed through a heat exchanger for extracting heat from the cooling water, and is subsequently passed through a further heat exchanger in which the temperature of the web is further elevated by heat present in the waste gases from the diesel engine plant

after the exhaust gases have passed through the exhaust gas heated boiler.

In the manufacture of paper and cardboard webs the mechanical removal of water from the web can be carried to a high degree by using electric pre-heating, either in the form of resistance heating or radiant heating, of the wet web so that essentially lower amounts of water need be evaporated. By such heating simultaneously a not insignificant amount of heat is carried into the drier, the heat acting from the interior outwards and favouring the drying. Processes for an improved removal of water have been proposed in which the web and felts of the plant are electrically conductive and are arranged in a current circuit and are thus heated by resistance heating, or the web and/or the felts are heated by infra-red irradiation, already during the mechanical water removal. With these processes a dryness value of 50% can be easily reached within the mechanical water removal stage. However, this degree of water removal is not sufficient to achieve subsequently a sufficient drying by means of the usual cylinder dryers using steam obtainable from the heat of the waste gases. Therefore with the present invention there are used for the web and the felt, within the mechanical water removal stage such electric heating devices in connection with the air drier, wherein the air is heated partly by heat in the cooling water and partly by heat in the exhaust gases of a diesel engine. In this way, the degree of water removal can be increased to such an extent that the residual water can be expelled with the aid of steam raised by heat in the exhaust gases.

Furthermore, with the present invention the previously proposed arrangement for utilizing waste heat of the exhaust gases of a diesel engine for creating steam in a steam boiler lying in the path of the exhaust gases is modified so that the exhaust gases, after leaving the steam boiler, flow subsequently through a heat exchanger for heating air required for drying.

In addition, heat contained in the cooling water of the diesel engine is utilized in the manufacture of the fibrous web. For this purpose, part of the cooling water is rendered effective in a first stage of an air preheater for the drying air so that the drying air, subsequently brought to a higher temperature by the residual heat of the exhaust gases, is already pre-heated to a great extent before the action of the exhaust gases on the drying air. A further part of the cooling water is used for heating circulating water of the machine or fresh water either directly or by employing a heat exchanger for the water which in the usual manner heats the web on the wire-cloth by means of a dandy roll. Furthermore, the cooling water is caused to flow through press rolls and guide rolls for the felts, the guide rolls being of sufficiently large dimensions, so

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	as to reduce the viscosity of the water contained in the web and in the felts by increasing the temperature of such water and thus decreasing its viscosity, thereby enabling a higher degree of water removal. Subsequently to the action of the air dryer which follows after the mechanical water removal stage, heat may be supplied to the web by infra-red radiation.	for heat generation, then theoretically 320 heat units are available in the form of steam or, assuming the boiler to be 80% efficient, 256 heat units. If the efficiency of the dry end for drying the paper is considered to be 66% then 169 heat units are available for drying the paper in the last stage.	70
5	When the amount of heat required for the removal of water from, and for the drying of, a fibrous web such as paper by the hitherto usual method of operation is compared with the amount of heat required in a method of the present invention, then the following picture results:—	It thus follows that with the invention the required drying heat in the steam can be obtained without difficulty from the exhaust gases of the diesel engine plant.	75
10	On an average, such fibrous webs, when entering a drying apparatus have a dryness degree of 38% and when emerging from the drying apparatus have a dryness degree of 95%. If it is assumed that the efficiency of the dry part is 100% then for heating the web and the water contained therein and also for the evaporation of the water 1010 heat units are required per kilogram of material of 100% dryness degree. This amount of heat has to be available in steam and has to be brought into action in a drying apparatus the efficiency of which, on an average, can be assumed to be 66%. In this case, primarily 1530 heat units for one kilogram of absolutely dry paper have to be supplied to the drying apparatus and, assuming an efficiency of 80% for the steam generation and steam distribution, 2220 heat units are primarily required for drying one kilogram of paper.	Thus a final drying from 75% absolute dryness to 95% absolute dryness can be effected by steam raised by using the utilizable heat in the exhaust gases.	80
15	By using the method of the present invention, namely that heat from the cooling water is rendered effective either directly or indirectly on the sieve and in the press part of a fibrous web manufacturing plant, and subsequently by electric heating the capability of the web for having so far increased the water removed therefrom is that after a final mechanical water removal stage only 50% water is contained in the paper, then for the remaining heating of the material and of the water contained therein as well as for evaporating this water, the amount of heat still required per kilogram of paper is only 617 heat units. If one follows recent discoveries in the manufacture of fibrous webs, namely that for obtaining a good smooth condition on a paper web it is sufficient for the web to be dried on cylinders from about 75% dryness degree up to the final dryness degree, then for the drying on cylinders only 152 heat units per kilogram of air dry paper are required.	However, assuming that in the mechanical water removal stage the paper can be brought to a dryness degree of 50%, then 617 heat units per kilogram of air dry paper are required, so that it has to be investigated whether, in the total heat supplied by the diesel engine plant and not converted into electrical energy for mechanical purposes, sufficient heat is available for drying the paper from 50% absolute dryness to 95% absolute dryness.	85
20	Since with the present invention for the water removal and drying 1.47 kilowatt-hours of electrical energy are required per kilogram of air dry paper, which requires a primary heat amount of 2800 heat units, and since in the steam boiler provided in the exhaust gas path approximately 60% of the 19% of the primary heat contained in the exhaust gases is utilizable	Basically 0.27 kilowatt-hour are available for electrical heating, with a heat content of - 19% of the primarily used heat of 3240 heat units per kilogram of paper = - - - and 21% of the primarily used heat of 3240 heat units per kilogram of paper, as derived from the cooling water = - - - The total heat amount available for drying per kilogram of air dry paper is thus - - -	90
25		226      95	
30		615      100	
35		1521      105	
40			110
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50			120
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## Heat Units

Basically 0.27 kilowatt-hour are available for electrical heating, with a heat content of - 19% of the primarily used heat of 3240 heat units per kilogram of paper = - - - and 21% of the primarily used heat of 3240 heat units per kilogram of paper, as derived from the cooling water = - - - The total heat amount available for drying per kilogram of air dry paper is thus - - -

From this figure it can thus be seen that the total efficiency of the heat exchange and heat transfer must be 41% in order to attain the theoretically required amount of 617 heat units. Since the electrical heat transfer operates with an efficiency of 85%, and the steam generation in the exhaust gas boiler operates with an efficiency of 80%, the heat exchange between water or exhaust gas and the drying air likewise operates with an efficiency of 80% and the air drying itself with an efficiency of 75%, a large part of the heat supplied by the diesel engine plant and not converted into mechanical or electrical energy is usable for drying the fibrous web and is also sufficient for drying the fibrous web.

Basically, using the method of the invention, per kilogram of air dry paper approximately 2800 heat units are required for drying and for driving the plant, while in the hitherto usual manner of supplying fibrous webs with heat and electric energy by means of a steam boiler installation 5000—6000 heat units had to be used per kilogram of air dry paper. Furthermore the operating expenses for the

diesel engine plant are essentially lower than those for a steam boiler installation and the financial outlay in erecting the diesel engine plant is essentially lower, notwithstanding its 5 higher efficiency, than that for a steam boiler installation.

**WHAT I CLAIM IS:—**

- 10 1. A method for the manufacture of fibrous webs, for example paper webs, wherein heat for drying a web and electric energy are derived from a diesel engine plant, the web being treated in apparatus comprising a wet part having a sieve portion, and a dry part having a press portion, a subsequent air drier and a cylinder drier, comprising the steps of directly or indirectly utilizing heat from cooling water of the diesel engine plant in the sieve portion and press portion to heat the fibrous web and to heat felts of the press portion for obtaining an improved water removal, and utilizing electric resistance heating or electric radium heating of the web and of the felt of the last press of the press portion using electricity generated by the diesel engine plant whereby further to
- 15 20 25 25 improve the water removal and increasing the temperature of the web, air for the subsequent air drier being heated by otherwise not utilizing

able waste heat of the exhaust gases and by heat remaining in the cooling water and not utilized in the sieve portion and the press portion, the web being preheated by electric radiators in a pre-drying zone preceding the cylinder drying part so that at the beginning of the cylinder drying part only such an amount of water remains in the web as can be dried out therefrom by heat derived from steam produced in an exhaust gas heated boiler.

30 35 40 45 2. A method as claimed in Claim 1, wherein the air required for drying the web is first passed through a heat exchanger for extracting heat from the cooling water, and is subsequently passed through a further heat exchanger in which the temperature of the web is further elevated by heat present in the exhaust gases from the diesel engine plant after the exhaust gases have passed through the exhaust gas heated boiler.

45 50 3. A method for use in the manufacture of fibrous webs substantially as hereinbefore described.

**WALTHER WOLFF,**  
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Chartered Patent Agent.

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